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PETROLOGY.—*An analcite-rich rock from the Deccan traps of India.*[1]

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In a study of the thin sections of a large collection of specimens of the Deccan traps in the possession of Dr. H. S. Washington a type was noted with a large proportion of a clear isotropic groundmass. This has a very low refractive index and is therefore quite distinct from the glassy groundmass occasionally found in some of the ordinary traps. The isotropic substance is, in fact, analcite and in other respects the rock is so unusual that its occurrence seems worthy of note.

The specimen is labelled "Deccan trap N.W. base of Ketool Hill, Cutch, India," and has the general appearance of an ordinary trap. The weathered surface has occasional pits that suggest amygdules but are in reality produced by the weathering out of olivine crystals which show as clear grains on the fresh break and are the only constituent of the rock identifiable in the hand specimen.

Under the microscope the rock is found to consist principally of analcite and pyroxene with a fair amount of olivine, as the small phenocrysts already noted, some nephelite, a little biotite, and rather abundant grains of an opaque ore mineral.

The pyroxene occurs as clusters and patches of minute felted prisms, some of which have the appearance of irregular individual grains in ordinary light, the composite character being clearly revealed, however, under crossed nicols. They average about 0.1 mm. in length and not more than $\frac{1}{3}$ that amount in width. The high extinction angle and high refractive indices (above 1.70) mark it as augite. It probably makes up nearly one-half the rock. Analcite acts as a matrix between the patches and streaks of augite but another mineral is found to be

[1] Received December 23, 1926.

interstitial to the prisms of augite of the felted mass when they are not too crowded to permit a determination of its presence. It has low refraction but, unlike the analcite, has a definite birefringence. Occasionally, on the border between augite clusters and analcite, definite prismoids of this mineral were observed which had weak birefringence, parallel extinction, negative elongation, and higher index than analcite but much lower than augite. They are in all probability nephelite.

In one thin section a rounded area about 2 mm. in diameter was noted in which the mineral constituents are somewhat different from those in the main mass. The mineral determined as probably nephelite is the principal constituent and in it are contained prisms of a pyroxene which, unlike the augite of the main rock, is decidedly green and undoubtedly somewhat acmitic. In addition to this there are grains of a strongly pleochroic deep-brown amphibole. This patch is, on a minute scale, analogous to the blebs of a pegmatitic character often seen in igneous rocks, especially those of an alkaline type.

Of the constituents of the main mass of the rock, again, analcite is perhaps a little less abundant than pyroxene. It occurs as a groundmass to the patches and clusters of augite prisms and its own distribution is therefore correspondingly patchy. It is entirely isotropic in thin section and the refractive index is between 1.485 and 1.495. Acid dissolves the mineral with separation of silica and the solution shows alumina and soda. There is no tendency for analcite to occur as euhedral individual crystals resembling leucite such as are common in analcite basalts. The patches of analcite are, however, granular, the border between grains being ordinarily marked by filaments of some substance of higher index and the shapes of the individuals strongly suggesting the polyhedral outlines appropriate to analcite.

Olivine is present as crystals that sometimes show an approach to euhedral outline but are generally of irregular shape and make up perhaps 10 to 15 per cent of the rock. They may be as much as 2 mm. in diameter and therefore far exceed in size the grains of any other mineral. The refractive index $\gamma = 1.70$ and 2V is nearly 90° so that the olivine must contain approximately 10 per cent FeO. In some grains it is entirely fresh and in others it may be completely transformed to serpentine.

Mica occurs in very subordinate amount and its relations to the pyroxene and ore suggest that it has been formed by reaction of the alkalic liquid with these minerals. Its strongest absorption is a pale brown and is in the normal position for biotite.

The ore mineral appears as small grains often of approximately octahedral shape.

Feldspar is entirely absent.

The Deccan traps are a thick series of basaltic lavas of the plateau type.[2] They are normally of ordinary basaltic composition and are made up almost exclusively of augite and plagioclase. The present rock is decidedly different. There is no information regarding its mode of occurrence and therefore no definite assurance that it is a lava, but the extremely fine prisms of augite suggest a rate of cooling that is consistent with such a mode of occurrence.

It is not possible to interpret the rock as an ordinary basalt in which analcite has replaced plagioclase for the augite has neither the granular character produced by extremely rapid chilling nor the ophitic character produced by somewhat less rapid chilling in ordinary basalt. The minute prisms are, indeed, such as appear to be characteristic of alkaline basalts. The presence of nephelite suggests the possibility that the rock was a nephelite basalt now strongly analcitized.

The evidence that analcite takes the place of other minerals, principally nephelite, is not clearly to be made out and is rather suggested than proved by its patchy distribution and the fact that nephelite rather than analcite is the matrix of the pyroxene prisms where they are most closely crowded. Occasionally, however, a seam of analcite is to be seen lying along the imperfect prismatic cleavage of nephelite. On the whole it would appear that the rock is a nephelite basalt which has suffered analcitization, but the possibility that it is an analcite basalt and the analcite dominantly primary can not be excluded.

In either case it is apparently the first example from the Deccan traps of a rock of such strongly alkaline affinities.

I am much indebted to Doctor Washington for the opportunity of examining his collection of these rocks.

BOTANY.—*New* Asteraceae *from Costa Rica.* S. F. BLAKE, Bureau of Plant Industry.[1]

The four new species described in this paper form part of the extensive collections of plants made in Costa Rica in 1924 and 1925–6 by Paul C. Standley of the U. S. National Museum. Notes on certain other species are added.

[2] H. S. WASHINGTON. *Deccan Traps and other Plateau Basalts.* Bull. Geol. Soc. Amer., **33**: 765–803. 1922.

[1] Received December 23, 1926.

Archibaccharis irazuensis Blake

Hemibaccharis irazuensis Blake, Contr. U. S. Nat. Herb. **20**: 551. 1924.

Dr. Johann Mattfeld of Berlin has called my attention to the fact that in describing the genus *Hemibaccharis*[2] I overlooked Heering's genus *Archibaccharis*,[3] founded on *Baccharis hieraciifolia* Hemsl. and *B. hirtella* DC. Of the 15 species recognized in my treatment, several have already been transferred to *Archibaccharis* in Standley's "Trees and Shrubs of Mexico." The six following species (all Mexican or Guatemalan) require transfer.

Archibaccharis corymbosa (Donn. Smith) Blake

Diplostephium corymbosum Donn. Smith, Bot. Gaz. **23**: 8. 1897.
Hemibaccharis corymbosa Blake, Contr. U. S. Nat. Herb. **20**: 553. 1924.

Archibaccharis flexilis Blake

Hemibaccharis flexilis Blake, Contr. U. S. Nat. Herb. **20**: 549. 1924.

Archibaccharis glandulosa (Greenm.) Blake

Baccharis glandulosa Greenm. Proc. Amer. Acad. **40**: 36. 1904.
Hemibaccharis glandulosa Blake, Contr. U. S. Nat. Herb. **20**: 546. 1924.

Archibaccharis hieracioides Blake

Baccharis hieraciifolia Hemsl. Biol. Centr. Amer. Bot. **2**: 129. 1881. Not *B. hieracifolia* Lam. 1783.
Archibaccharis hieraciifolia Heer. Jahrb. Hamb. Wiss. Anst. **21**: Beiheft **3**: 40. 1904, as to synonym only.
Hemibaccharis hieracioides Blake, Contr. U. S. Nat. Herb. **20**: 547. 1924.

Heering's treatment of this species is far from clear. Although he published the name as "*A. hieraciifolia* Heering n. spec." and cited Hemsley's synonym with a mark of interrogation, he apparently did not consider the plant referred to (*Pringle* 6257) a new species, for he gave no diagnosis, merely remarking that Hemsley's description called for leaves attenuate at both ends and petioled or subsessile, while in his plant they were sessile and auriculate. *Pringle* 6257 is in fact the type number of *Baccharis glandulosa* Greenm. (1904), a species distinct from *B. hieraciifolia* Hemsl. In the case of his second numbered species, Heering was similarly ambiguous, listing it as "*A. hirtella* Heering n. spec.," but citing "*B. hirtella* DC. . . . . ex descr." and "*B. hirtella* Klatt! Leopoldina XX. (1884), p. 4" among the synonyms. On the whole, it seems advisable to treat these two names of Heering as representing new combinations rather than new species. A third species, *Archibaccharis schultzii* Heer. (l. c. 41), based on *Liebmann* 425, is mentioned by Heering with a few words of description quite insufficient to permit the recognition of the species in the absence of specimens.

Baccharis hieraciifolia Hemsl. was based on *Bourgeau* 951 and 1230, both from Desierto Viejo, Valley of Mexico. Both numbers, as represented in the

[2] Contr. U. S. Nat. Herb. **20**: 544. 1924.
[3] Jahrb. Hamb. Wiss. Anst. **21**: Beiheft **3**: 40. 1904.

Kew Herbarium, belong to the species with naked petioles, *Archibaccharis hieracioides*. The specimen of *Bourgeau* 1230 in the U. S. National Herbarium, however, is *A. glandulosa* (Greenm.) Blake, with amplexicaul-based leaves.

Archibaccharis salmeoides Blake

Hemibaccharis salmeoides Blake, Contr. U. S. Nat. Herb. **20**: 548. *pl. 50*. 1924.

Archibaccharis simplex Blake

Hemibaccharis simplex Blake, Contr. U. S. Nat. Herb. **20**: 547. *pl. 49*. 1924.

Gnaphalium rhodarum Blake, sp. nov.

Annual, leafy; stem lanate-tomentose and stipitate-glandular; leaves lanceolate, acuminate, green and glandular above, arachnoid-tomentose beneath, short-decurrent; heads rosy, medium-sized, in close glomerules crowded in a small panicle.

Single-stemmed, 24–30 cm. high or more, erect, the stem or the few branches simple below the inflorescence, lanate-tomentose with whitish wool, densely so toward apex, toward base glabrescent, exposing the dense stipitate glands; leaves nearly uniform, 2.5–5 cm. long, 4–8 mm. wide, with attenuate dark callous tips, broadest toward base and decurrent in rather broad wings 3–8 mm. long, repand, very narrowly revolute-margined; heads campanulate-subglobose, about 4 mm. high and thick, glomerate at tips of the usually few and short branches of the panicle, the glomerules 1–1.8 cm. thick; pistillate flowers 37, hermaphrodite 10; involucre 4 mm. high, about 3-seriate, somewhat graduate, the phyllaries broadly ovate to oblong, obtuse or slightly apiculate, somewhat erose, the concealed green base arachnoid, the tips bright rosy or becoming light brown in age; corollas whitish; achenes oval-oblong, plump, 0.7 mm. long, papillose, otherwise glabrous; pappus bristles white, deciduous separately, not thickened above.

Costa Rica: In paramo, Cerro de las Vueltas, Province of San José, alt. 2700–3000 meters, 29 Dec. 1925–1 Jan. 1926, *Standley & Valerio* 43623 (type no. 1,253,330, U. S. Nat. Herb.); in open forest, same data, *Standley & Valerio* 43961; Cerro de Buena Vista, alt. 3100 meters, 19 Jan. 1891, *Pittier* 3433.

Pittier's plant was determined by Klatt as *Gnaphalium roseum* H. B. K., to which *G. rhodarum* is related. In *G. roseum*, however, the leaves are persistently tomentose above and much less conspicuously decurrent.

The specific name is Latinized from *'ροδαρός,' rosy*, a word given in Schrevelius' Lexicon but not in Liddell and Scott.

Gnaphalium subsericeum Blake, sp. nov.

Low herb; stem simple, white-lanate-tomentose; leaves rather few, linear, attenuate, green above, closely subsericeous-tomentose with white hairs beneath, not decurrent; heads small, numerous in a small dense cymose panicle; phyllaries narrow, blackish green below the obtusish firm white tips; corollas reddish-purple above.

Stems 11–16 cm. high, erect, solitary (or paired?) from an apparently perennial slender root, densely and subsericeously lanate-tomentose; leaves nearly uniform (the upper only slightly shorter), about 12 above base of

stem, 3.5–6 cm. long, 3–5 mm. wide, attenuate to a callous brownish tip, sessile, not narrowed at base, entire, firm, above deep green, glabrescent or glabrate, very narrowly revolute-margined, the narrow green costa evident beneath; heads campanulate, 4 mm. high, 2.8 mm. thick, glomerate on the very short branches, forming a very dense rounded panicle 3–3.5 cm. thick; pistillate flowers 69, hermaphrodite 8; involucre 4 mm. high, about 5-seriate, rather strongly graduate, the outer phyllaries ovate, obtuse, the inner linear, obtuse or acutish, all with narrow greenish midline below, bordered by whitish, then by a narrow line of shining yellow brown, blackish or greenish black below the white chartaceous apex, thinly arachnoid below; achenes angled, 0.6 mm. long, nearly glabrous; pappus bristles apparently deciduous in groups, those of the hermaphrodite flowers slightly stouter than the pistillate, but not clavate-thickened.

COSTA RICA: Wet meadow, La Palma, Province of San José, alt. 1600 meters, 3 Feb. 1924, *Standley* 32941 (type no. 1,226,057, U. S. Nat. Herb.).

Evidently related to *Gnaphalium salicifolium* (Bertol.) Sch. Bip. (*G. rhodanthum* Sch. Bip.), which ranges from Mexico to Guatemala. In *Gnaphalium salicifolium* the stem is distinctly indurate below or even suffrutescent, and densely leafy, the leaves are less attenuate, persistently tomentose above and not subsericeous beneath, the heads distinctly larger, and the phyllaries usually purple-tinged.

RENSONIA SALVADORICA Blake, Journ. Washington Acad. Sci. 13: 145. 1923. Fig. 1.

This species, the only representative of its genus, was described from three collections made by Mr. Standley in the Department of Ahuachapán, Salvador, in January 1922. The original material was in mature fruit, and did not show the character of the ray corollas. The description of the genus can now be completed from further material of the same species collected in January 1926 at five different localities in the Cordillera of Tilarán, Province of Guanacaste, Costa Rica, at 500–700 meters altitude, by Paul C. Standley and Juvenal Valerio (nos. 44224, 45572, 45828, 46083, and 46455). The specimens are described as collected from erect or ascending, usually subscandent, rarely epiphytic shrubs 1–4.5 m. high, common in moist or dry forest. The following characters should be added to the generic description:

Corollas all yellow; rays 8, fertile, 1-seriate, spreading, about equaling the disk (tube hispidulous above, 1.3 mm. long; lamina oval-oblong, shallowly or rather deeply 2-lobed, with one of the lobes sometimes bidentate, 3.8–5 mm. long, 2.5 mm. wide, hispidulous on back chiefly on the nerves, 8–9-nerved, 2 of the nerves much stronger than the others); ray achenes usually with a pappus of a single stout hispidulous awn or tooth (0.8 mm. long or less) on the inner side; pappus of disk achenes a short, thick, hispidulous-ciliolate crown, usually prolonged into 1–3 unequal teeth or short awns 1.2 mm. long or less.

Hieracium sphagnicola Blake, sp. nov.

Section *Crepidisperma*; phyllopodous; basal leaves oblanceolate, up to 17 cm. long, thin, sparsely long-pilose; stem rather tall, bearing 0–2 elongate leaves below the middle, sparsely long-pilose below, loosely cymose-branched above, bearing 5–8 heads on elongate, flexuous, flocculent, finely glandular, and apically pilose peduncles; involucre narrowly campanulate, 8–11 mm. high, stipitate-glandular and sparsely pilose, chiefly toward base; achenes

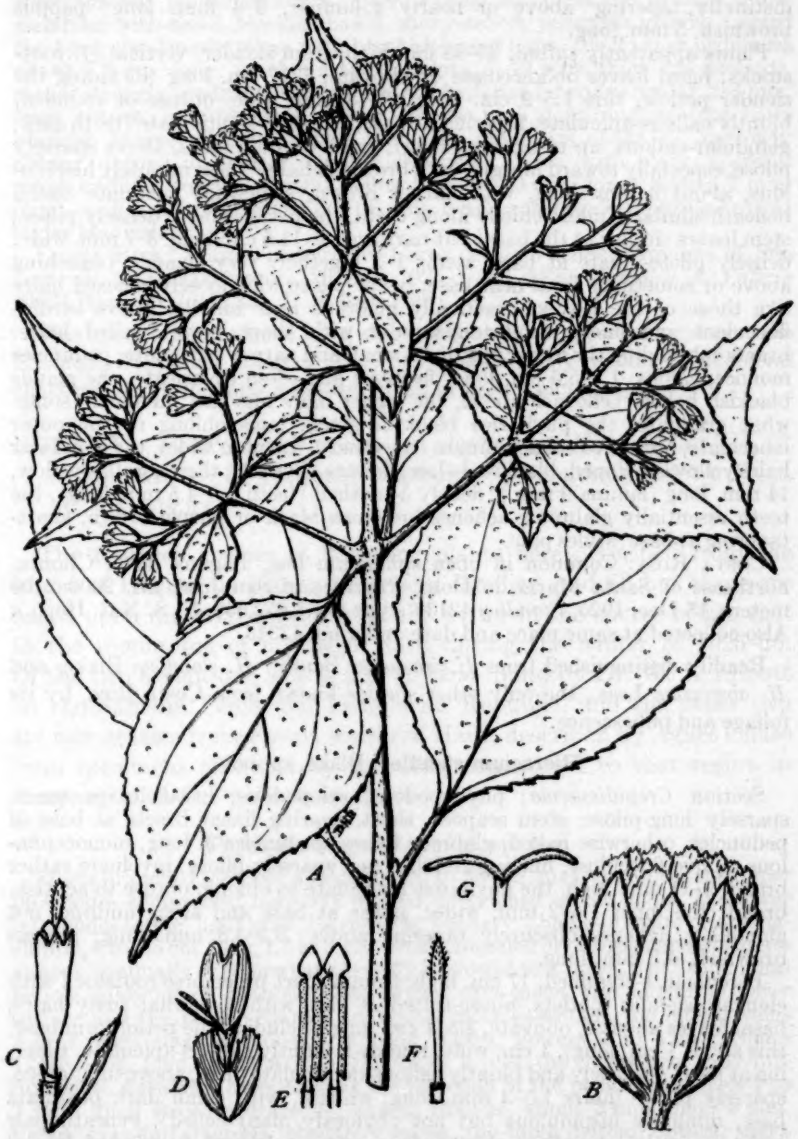

Fig. 1. *Rensonia salvadorica* Blake (drawn from *Standley & Valerio* 45572).—*A*, portion of plant, ×1; *B*, fruiting head, ×6; *C*, disk floret and pale, ×5; *D*, ray floret, ×4; *E*, stamens, ×10; *F*, style and nectary of disk floret, ×10; *G*, style branches of ray floret, ×10.

distinctly tapering above or nearly columnar, 3–4 mm. long; pappus brownish, 5 mm. long.

Plants apparently tufted, 35–85 cm. high, from slender, vertical (?) rootstocks; basal leaves oblanceolate or obovate, 7–17 cm. long (including the slender petiole, this 1.5–9 cm. long), 8–18 mm. wide, obtuse or rounded, bluntly callous-apiculate, tapering at base, remotely denticulate (teeth dark, glandular-callous, up to 0.5 mm. long), green on both sides, above sparsely pilose, especially toward margin, with brownish hairs (these minutely hispidulous, about 3 mm. long, with darker brown, somewhat pustulate base), beneath similarly pilose chiefly along costa, the petioles more densely pilose; stem leaves similar to the basal but narrower, 6–11.5 cm. long, 3–7 mm. wide, densely pilose-ciliate at base; stems 1–2 together, very slender, branching above or sometimes from near base, below pilose with loosely reflexed hairs like those of the leaves, practically glabrous near middle, above sordid-flocculent and finely stipitate-glandular with short, several-celled hairs; bracts subtending the upper peduncles small and narrow or minute; peduncles monocephalous, 1.5–5.5 cm. long, flexuous and often divaricate, the glands blackish below, yellowish above, the longer hairs blackish; involucre somewhat graduate, the phyllaries blackish green, lance-oblong or the outer lanceolate, obtuse to subacuminate (the inner 1–1.3 mm. wide), the glandular hairs yellowish-tipped, blackish below; flowers about 23, their corollas yellow, 14 mm. long (lamina 9 mm.), deeply 5-toothed (teeth 3.5–4.5 mm. long), the teeth essentially glabrous; achenes brownish black or purple brown, short-tapering at base; styles pale.

COSTA RICA: Common in open sphagnum bog, Laguna de la Chonta, northeast of Santa Maria de Dota, Province of San José, alt. 2000–2100 meters, 18 Dec. 1925, *Standley* 42139 (type no. 1,252,630, U. S. Nat. Herb.). Also collected at same place and date under no. 42343.

Readily distinguished from *H. irasuense* Benth., *H. standleyi* Blake, and *H. abscissum* Less., the only other species known from Costa Rica, by its foliage and pubescence.

Hieracium standleyi Blake, sp. nov.

Section *Crepidisperma*; phyllopodous, eriopodous; basal leaves small, sparsely long-pilose; stem scapose, short, bearing linear bracts at base of peduncles, otherwise naked, glabrous below; peduncles 3, long, monocephalous, above flocculose, finely glandular, and sparsely pilose; involucre rather broad, 9–11 mm. high, the phyllaries lanceolate to oblong, obtuse to acutish, broad (the inner 1.5–2 mm. wide), pilose at base and along midline, not glandular; achenes obscurely tapering above, 2.5–3.8 mm. long; pappus brownish, 4.5 mm. long.

Perennial, 1-stemmed, 17 cm. high, from a short praemorse rootstock with elongate slender rootlets, pilose-tufted at base with somewhat rusty hairs; basal leaves about 6, obovate, 3.5–4 cm. long (including the petioliform base, this about 1 cm. long), 1 cm. wide, rounded, bluntly callous-apiculate, tapering at base, obscurely and bluntly callous-denticulate, firm, above light green, sparsely pilose (hairs 1.5–3 mm. long, whitish, with small dark pustulate base, minutely hispidulous but not obviously many-celled), beneath pale green, sparsely long-pilose chiefly along costa and the 4–5 pairs of lateral veins; scape 3-headed, the unbranched portion 1.8 cm. long, practically glabrous, the lowest peduncle 13.5 cm. long, 1-headed and with an abortive lateral head, subtended by a linear-spatulate bract 2 cm. long and 1 mm.

wide, sparsely pilosulous below, above loosely flocculose and densely short-glandular with small, blackish-based, many-celled, yellowish glands, toward the head also loosely pilose with blackish-based hairs, the 2 other peduncles about 7.5 cm. long; involucre campanulate, 7–10 mm. thick (as pressed), rather strongly graduate, the outermost phyllaries lance-triangular, 2–4 mm. long, obtuse, blackish-green, pilose at base and along midline (the hairs blackish below, whitish above), the inner phyllaries about 13, narrowly oblong, obtuse, or acutish, thinner and paler above, with black, sparsely pilose midline; corollas "bright yellow," about 10 mm. long (lamina 7 mm. long), with 5 glabrous teeth (1.3–1.8 mm. long); achenes deep purple-brown; styles blackish-green.

COSTA RICA: Scarce, in paramo, Cerro de las Vueltas, Province of San José, alt. 2700–3000 meters, 29 Dec. 1925–1 Jan. 1926, *Standley & Valerio* 43624 (type no. 1,253,331, U. S. Nat. Herb.).

This species, represented by a single specimen, is apparently nearest the Mexican *Hieracium junceum* Fries, but is abundantly distant in involucral characters from that species as described in Zahn's monograph.

BOTANY.—*Fourteen new species of plants from Hispaniola.*[1] E. C. LEONARD, U. S. National Museum. (Communicated by PAUL C. STANDLEY.)

The fourteen species of flowering plants here described from the island of Hispaniola belong to several families, and all but three are based upon material collected by the writer in the course of his visit to the mountains of northern Haiti during the winter of 1925–26. Of the two exceptions, one is a *Brunfelsia* found by Dr. W. L. Abbott on the Samaná Peninsula, Dominican Republic, and the other two are new grasses from Furcy, southern Haiti, described by Agnes Chase from specimens obtained by the writer on a visit to that region in company with Dr. Abbott, in 1920.

Phthirusa siegeri Leonard, sp. nov.

Stems branched, erect or ascending, 20 to 50 cm. high, glabrous, the upper internodes compressed narrowly winged, broadened at the nodes, the lower internodes terete, light gray; leaves firm, leathery, oblong-obovate or oblong-elliptic, 4 to 7.5 cm. long, 1.5 to 3 cm. broad, rounded or obtusish and apiculate at apex, gradually or somewhat abruptly narrowed to a short (2 to 5 mm. long) petiole, glabrous on both surfaces, drying olive-green, the midrib on lower surface and the petiole sharply triangular in cross-section, the lateral veins 3 or 4 pairs, inconspicuous in younger leaves; flowers 2 to 4 in racemes 1.5 to 3 cm. long, in the axils of the upper leaves, the rachis light gray-furfuraceous, flattened, broadened at the insertion of the pedicels; pedicels 1 to 2 mm. long, gray-furfuraceous; cupule shallow, about 2 mm. long, 4 mm. broad, gray-furfuraceous, obscurely lobed, the lobes deltoid, obtuse; calyx

[1] Published by permission of the Secretary of the Smithsonian Institution. Received December 29, 1926.

minute, entire; petals 6, yellowish without, reddish within, thick, linear-oblong, 2 to 5 mm. long, 0.75 mm. broad at base, gradually narrowed from middle to an acute tip; stamens 6, attached to the petals about 1 mm. above their base, the 3 sterile ones 1.5 mm. long, excavate on the margins below the triangular sterile anther (this 0.75 mm. broad), the 3 fertile stamens 1 mm. long, their anthers oval, apiculate, about 0.05 mm. broad; style fusiform, scarcely 2 mm. long; berry oval, black, 1 cm. long, 6 mm. broad, minutely reticulate.

Type in the U. S. National Herbarium, no 1,149,122, collected from a tree on a dry plain east of the Atalaye Plantation, vicinity of St. Michel, Department du Nord, Haiti, altitude 350 meters, November 18, 1925, by E. C. Leonard (no. 7166).

Additional specimens examined:

HAITI: Mt. La Mine, vicinity of St. Michel, November 19, 1925, *Leonard* 7227. Dry bank along the Puilboreau road, north of Ennery, Department de l'Artibonite, altitude 400 meters, January 17, 1926, on *Poitea multiflora* (Sw.) Urb., *Leonard* 8903; February 13, 1926, *Leonard* 9715. Dry thickets on mountain slope southeast of Ennery, January 19, 1926, *Leonard* 8971.

Phthirusa siegeri is easily distinguished by the short, stout, few-flowered, light gray-furfuraceous racemes, large black oval berries, and small yellowish flowers. The species is named for Mr. E. J. Sieger, manager of the United West Indies Corporation, who assisted me greatly in my work at St. Michel.

Coccoloba revoluta Leonard, sp. nov.

Small tree with numerous spreading branches; bark light gray; young twigs puberulent, striate, slightly swollen at the nodes, the internodes 1 to 2.5 cm. long; ocreae 5 mm. long, obliquely 2-lobed at tip, the lobes short, obtuse; petioles 3 to 4 mm. long, 2 mm. broad at base, flat, puberulent above, glabrous beneath; leaves ovate, 2 to 4.5 cm. long, 1.5 to 3 cm. broad, rounded or obtuse at apex, subcordate at base, firm, revolute, drying olive-green, glabrous and prominently but minutely reticulate on both surfaces, the principal nerves 4 to 5 pairs, obscure above, prominent beneath; flowers and fruit not seen.

Type in the U. S. National Herbarium, no. 1,149,188, collected in a dry thicket several miles north of the Atalaye Plantation, vicinity of St. Michel, Department du Nord, Haiti, altitude 350 meters, December 26, 1925, by E. C. Leonard (no. 8499). No. 7244, collected November 20, 1925, at the same locality is of this species.

In shape and texture of leaf blades this species closely resembles *C. pilonis* Urb. and *C. krugii* Lindau, but in neither of these species is the upper surface of the leaf blades prominently reticulated, and both have longer and more slender petioles.

Coccoloba fulgens Leonard, sp. nov.

Small tree 3 to 6 meters high; stems, leaves, and inflorescence glabrous; twigs reddish brown; ocreae 5 to 8 mm. long, oblique at tip, soon deciduous; petioles 2 to 10 mm. long; leaf blades oblong-elliptic to obovate, 2 to 5 cm. long, 15 to 25 cm. broad, round at apex, narrowed from middle to petiole, acutish or obtuse at base, entire, firm, shining, yellowish green when dry, both surfaces coarsely and prominently reticulate, the lower surface minutely

glandular-punctate, the principal lateral veins 4 or 5 pairs; racemes solitary, terminal on small branches, 2 to 3 cm. long, the fruits 20 to 35, somewhat crowded; ocreolae 0.75 mm. long; flowers not seen; pedicels 1 mm. long; fruit reddish brown, pyriform, 6 mm. long, 4 mm. thick, the accrescent sepals closed over fruit, triangular, blunt, about 2.5 mm. long.

Type in the U. S. National Herbarium, no. 1,300, 397, collected in a thicket on the Puilboreau Pass between Ennery and Plaisance, Département de l'Artibonite, Haiti, altitude 900 meters, January 23, 1926, by E. C. Leonard (no. 9145).

In fruit and shape of leaf blades this plant resembles *C. obtusifolia* Jacq. but that species has puberulent stems and petioles, a longer and more slender rachis, and larger leaves.

Aeschynomene aurea Leonard, sp. nov.

Herbaceous, branched at base, the branches slender, erect or ascending, leafy to the summit, striate, sparingly and minutely strigose with white hairs, or the hairs on the tips of the branches spreading; stipules sessile, ovate or lanceolate, rounded at base, acute or acuminate, prominently nerved, sparsely strigillose or glabrous; leaves 1.5 to 3 cm. long, hispidulous with white hairs, the petioles 3 to 4 mm. long, the petiolules 0.5 mm. long, the leaflets 6 to 11 pairs, 5 to 6 mm. long, 2 to 2.5 mm. wide, oblique and subcordate at base, oblique and obtuse at apex, prominently reticulate-veined beneath; flowers few, in axillary or terminal racemes up to 3 cm. long; pedicels 5 to 10 mm. long, pubescent with white, appressed or spreading hairs; bracts ovate, 1.5 mm. long, acutish, prominently parallel-veined; calyx 4 mm. long, sparsely strigillose, 2-lipped, the 2 lower lobes obtuse, the 3 upper ones triangular and acuminate; corolla golden yellow, the standard ovate to suborbicular, about 9 mm. long, 8 mm. broad, more or less pubescent without, the claw cuneate, 2 mm. long, 2 mm. broad above, the wings obliquely obovate, as long as the standard, the claw slender, the keel curved, obliquely truncate, about 5 mm. long; stamens diadelphous, the united portion of the filaments 4.5 mm. long, the free portion 1.5 to 2 mm. long; ovary stipitate, 5 mm. long, minutely pubescent; style about 4 mm. long, abruptly bent, glabrous above, pubescent below; pods 2 to 2.5 cm. long, flat, 3 to 5-jointed, reticulate, appressed-pubescent, deeply constricted below, the tip hair-like, about 5 mm. long.

Type in the U. S. National Herbarium, no. 1,300,172, collected on the Puilboreau road above Ennery, Département de l'Artibonite, Haiti, altitude 800 meters, January 13, 1926, by E. C. Leonard (no. 8818).

Aeschynomene aurea is closely related to *A. tenuis* Griseb., a Cuban species, but the two plants differ strikingly in several respects. The stems of *A. tenuis* are glabrous and bear but few leaves which are mostly near the base, the leaflets are narrower, the flowers smaller, and the pods glabrous or but very sparsely strigillose, very obscurely reticulate, and thick-margined. The stems of *A. aurea* are strigose and leafy to the summit and the pods are appressed-puberulent, prominently reticulate, and not thick-margined.

Galactia retrorsa Leonard, sp. nov.

Twining vine; stem retrorsely pilose with yellowish hairs about 0.5 mm. long; stipules retrorsely pilose, 3 to 4 mm. long; petioles 2 to 6 cm. long, retrorsely pilose; leaflets 3; petiolules pilose with yellowish, appressed or ascend-

ing hairs, those of the lateral leaflets 1 to 2 mm. long, those of the terminal one 5 to 10 mm. long; leaf blades oblong-elliptic, rounded at both ends, firm, entire, the upper surface with a few hairs on the mid-rib, the lower surface velvety-appressed-pilose, the hairs on midrib denser and yellowish, the veins reticulate but not prominent; flowers numerous, in axillary racemes reaching 6 cm. in length; peduncles very short or none, the pedicels slender, 2 to 3 mm. long, pilose with minute, whitish, spreading, retrorse or appressed hairs; calyx slightly 2-lipped, about 5 mm. long, minutely appressed-pilose or a few of the hairs ascending, the lobes 1.5 mm. long, triangular, with an awnlike tip; corolla bright purple, about 8 mm. long, the standard orbicular, 5 mm. broad, emarginate, the claw 3.5 mm. long, 1.5 mm. broad, narrowed to 0.5 mm. at base, the wings obovate, 5 mm. long, 2 mm. broad, the keel curved, rounded, emarginate, about 3 mm. long; stamens diadelphous, the tube and single stamen 5.5 mm. long, the free portion of the 9 united stamens 0.5 mm. long, the stamen tube narrowed above; stigma 3 mm. long, appressed-pubescent.

Type in the U. S. National Herbarium, no. 1,149,590, collected on hillside near small stream on the north slope of Mt. Platanna, in the vicinity of St. Michel, Haiti, altitude about 350 meters, December 7, 1925, by E. C. Leonard (no. 7811). No. 8119, collected in the vicinity of Marmelade, and no. 9228 from Plaisance, are to be referred to this species. They were taken from fruiting plants and differ from the type in their relatively shorter leaf blades and more sparsely pubescent stems. The pods are 2.5 to 3 cm. long, 5 mm. broad, slightly curved, abruptly narrowed at the apex to a short curved tip, and appressed-pilose with minute yellowish hairs. The seeds are dark greenish brown or black, flat, 3.5 mm. long and 2 to 2.5 mm. broad.

This well-marked species is characterized by the large rounded-elliptic leaflets, densely flowered, sessile racemes, and yellowish retrorse pubescence of stem and petiole.

Trichilia truncata Leonard, sp. nov.

Shrub or small tree 1 to 3 meters high; young twigs puberulent, the older twigs glabrous or sparingly puberulent, the lenticels round, about 0.5 mm. in diameter, prominent; leaves odd-pinnate; rachis 2 to 6 cm. long, puberulent; petiolules thick, 1 to 2 mm. long; leaflets 3 or 5, subopposite, 4 to 11 cm. long, 2 to 5 cm. broad, firm, leathery, drying bright green, extremely variable, cuneate or narrowly obovate, broadest above the middle, gradually narrowed from the broadest portion to the base, the margins straight or curved, entire, truncate and 3-lobed at apex, or, if narrowed, undulate or coarsely toothed, the apex and teeth or lobes blunt, the upper surface glabrous, the midrib impressed, the lower surface with prominent puberulent midrib and veins, the principal lateral veins 5 to 11 pairs, the secondary ones reticulate; flowers racemose, terminal, in the axils of the upper leaves, the racemes small, about 1 cm. long, the branches puberulent; pedicels 1 mm. long, puberulent; lobes of the calyx triangular, acute, pubescent; flowers not seen; fruit obovoid, 7 to 10 mm. long, velvety-pubescent.

Type in the U. S. National Herbarium, no. 1,300,370, collected along the Puilboreau road, vicinity of Ennery, Haiti, altitude 900 meters, January 21, 1926, by E. C. Leonard (no. 9095). Additional specimens were collected near Marmelade, altitude 800 meters, December 20, 1925 (*Leonard* 8275 and 8288). No. 8288 consists of seedlings about 30 cm. high with both juvenile and mature leaves. The juvenile leaves are linear, 8 to 18 cm. long, 0.3 to 1 cm. wide, and blunt at apex.

This strange plant is found in thickets on the broken lime-capped summits of the higher mountain ranges of northern Haiti. It is probably related to *T. pallida* Sw., which it closely resembles in all respects except in the peculiar cuneate, truncate or lobed leaves. *T. cuneifolia* Urb., a species found in the Dominican Republic, has this type of leaf but the lobes are tipped with prominent spines.

Croton ekmanii Leonard, sp. nov.

Monoecious aromatic shrub about 1 meter high; branches slender; young twigs minutely stellate-pubescent and pilose (each long hair a prolonged ray of one of the stellate hairs); older twigs smooth, gray; petioles very slender, 1 to 3 cm. long, rather sparingly pilose and stellate-pubescent; leaf blades ovate, 2 to 5 cm. long, 1.5 to 2.5 cm. broad (those of the short axillary branches much smaller), obtusish and apiculate at apex, rounded or subcordate at base with a very narrow sinus, thin, entire or undulate, the upper surface dull green, sparingly stellate-pubescent, becoming papillose and subscabrous on loss of the pubescence, the veins obscure, the lower surface grayish green, pilose and stellate-pubescent, the long hairs predominating on the younger leaves, the 4 to 6 lateral veins and midrib rather prominent; glands 1 or 2 pairs on the petiole at base of leaf blade, slender, hair-like, 1 to 1.5 mm. long; flowers few, in small axillary racemes up to 1 cm. long; pistillate flower solitary, the pedicel 1.5 mm. long, pilose and stellate-pubescent, the sepals triangular, 1.5 mm. long, 0.5 mm. broad at base, the styles branched, clawed at tip, bearing several white stellate scales; capsule (immature) densely white-stellate-pubescent; staminate flowers 4 to 6, subsessile on a slender rachis, sparingly pilose and stellate-pubescent, the sepals ovate-lanceolate, slightly falcate, 1.25 mm. long, 0.75 mm. broad, acutish at apex, the petals obovate, pilose at base, shorter than the sepals; stamens 16 to 20, the filaments glabrous, the anthers, oval, about 0.5 mm. long; mature fruit not seen.

Type in the U. S. National Herbarium, no. 1,301,545, collected along stream on the Atalaye Plantation, vicinity of St. Michel, Département du Nord, Haiti, November 17, 1925, by E. C. Leonard (no. 7030).

This species is readily distinguished by its thin ovate leaves, slender petioles with hairlike glands, and by the two types of pubescence.

Thouinia milleri Leonard, sp. nov.

Shrub or small tree reaching 4 meters in height; bark smooth, reddish brown, the lenticels prominent; young twigs appressed-puberulent; petioles 1.5 to 3 mm. long, glabrous; leaflets 3; petiolules 1 mm. long; lateral leaflets oblong-ovate or oblong to linear-lanceolate, 2 to 10 cm. long, 1 to 1.5 cm. broad, the terminal leaflet linear-lanceolate, 10 to 25 cm. long, 1.5 to 2.2 cm. broad, all obtuse and apiculate at apex, narrowed at base, firm, serrate, the teeth low, tipped by the excurrent lateral veins, glabrous above, puberulent beneath, the midrib and lateral veins prominent on lower surface, the lateral veins numerous, parallel, widespreading, joining the midrib nearly at right angles, the veinlets prominently reticulate; flowers numerous, in crowded, axillary and terminal racemes 3 to 6 cm. long; pedicels slender, 3 to 4 mm. long, puberulent; sepals 4, obovate, ciliate with minute blunt hairs composed of square or oval cells, dissimilar, 2 of the sepals keeled, 1 mm. long, the other 2 concave, 1.75 mm. long; petals white, cuneate, 3 mm. long, the apex truncate, undulate, bearing a pair of small bearded scales on the claw 0.75 mm. above its base; stamens 8, the filaments slender, slightly exceeding

the petals; anthers white, oval, 0.5 mm. long; ovary 0.5 mm. long, winged; ovules 2.

Type in the U. S. National Herbarium, no. 1,300,595, collected at the base of a cliff along the Gonaives road about 5 miles from Ennery, Département de l'Artibonite, altitude 325 meters, February 3, 1926, by E. C. Leonard (no. 9472). Two additional specimens from Haiti were examined, one collected among rocks at the mouth of the caverns north of St. Michel, December 5, 1925, by Leonard (no. 7750); the other near l'Arcahaie, March 10, 1925, by G. S. Miller (no. 267). *Miller* 267 is a twig bearing leaves and a raceme of mature fruit. The samaras are greenish, spreading, obovate, the dorsal edge straight, the ventral curved, 2 cm. long, 7 mm. broad, somewhat striate, and puberulent. The seeds are obovate, 3 mm. long, 2 mm. broad and sparingly puberulent.

T. patentinervis Radlk., a Cuban species, is closely related to this plant, but has leaf blades not exceeding 7 cm. in length and smaller flowers.

Tetrazygia brevicollis Leonard, sp. nov.

Round-topped shrub about 2 meters high; bark light gray, smooth; young branches sparingly and minutely stellate-furfuraceous; petioles 3 to 6 mm. long, gray-stellate-furfuraceous; leaves often erect, the blades oblong-elliptic, 3 to 5 cm. long, 1 to 2 cm. broad, acutish or obtuse at apex and tipped by a blunt mucro 0.5 mm. long, rounded at base, firm, entire, revolute, the upper surface shining, the midrib channeled, the lateral veins obscure, the lower surface light gray, densely and smoothly stellate-furfuraceous, 5-nerved, the first pair of nerves slender and near the margin of the leaf blade, joining the midrib at base, the midrib and second pair of nerves prominent, the latter joining the midrib about 2 mm. above the base, the lateral nerves numerous, wide-spreading, slender, impressed; flowers 1 or 2 on each of the pair of terminal peduncles; peduncles 13 mm. long, slightly flattened, furfuraceous, subtended by the upper pair of leaf blades; pedicels 1 mm. long; calyx rather sparsely white-stellate-furfuraceous, the tube 2 mm. long, the lobes triangular, acuminate, 3.5 mm. long, spreading; corolla not seen; fruit (immature in specimen examined) oval, 5 mm. long, 4 mm. thick, sparsely stellate-furfuraceous, becoming glabrous.

Type in the U. S. National Herbarium, no. 1,149,939, collected on a dry slope six miles north of the Atalaye Plantation, vicinity of St. Michel, Département du Nord, Haiti, altitude 400 meters, December 26, 1925, by E. C. Leonard (no. 8461).

This species is very close to *T. longicollis* Urb. & Cogn., but differs in having smaller leaves and inflorescence and a much shorter calyx tube. *T. longicollis* is described as having a calyx tube 7 to 8 mm. long, panicles 3 to 5 cm. long, and leaves reaching 6 cm. in length.

Hyptis congesta Leonard, sp. nov.

Herbaceous, about 50 cm. high; stem erect, or ascending at base, simple or sparingly branched, square, the angles rounded, the four sides prominently channeled, finely striate, closely puberulent with white curved hairs, also sparingly pilose above, 4 mm. thick; petioles 1 to 3 cm. long, white-tomentose and pilose; leaf blades oblong-ovate, 2 to 5.5 cm. long, 1 to 2.5 cm. broad, cordate at base, gradually narrowed to an acute or acutish apex, both surfaces tomentose, the lower surface whitish and strongly reticulate, coarsely serrate

the teeth crenulate, the axils of the leaves with short branches bearing small leaves; floral bracts similar to and intergrading with the stem leaves; flowers in short cymes, the cymes crowded in a terminal spikelike cluster at the summit of the stem; pedicels 1 to 2 mm. long, puberulent; calyx 8 to 9 mm. long, 4 mm. broad at throat, 3 mm. at the rounded base, 10-nerved, tomentose, the margin ciliate, the teeth abruptly linear, 2 to 2.5 mm. long, involute, pilose; corolla light purple or lavender, pubescent at least above, about 5 mm. long, the upper lip obcordate, spreading, the lower lip 3-lobed, the lobes rounded, reflexed; stamens 4, didynamous, the filaments about 1 mm. long, pilose, the anthers oval, 1.5 mm. long; style reaching mouth of corolla, the stigma 2-lobed, the lobes spreading; mature nutlets not seen.

Type in the U. S. National Herbarium, no. 1,149,437, collected on dry calcareous slopes north of Mt. La Cidre, Département du Nord, Haiti, altitude 300 meters, November 30, 1925, by E. C. Leonard (no. 7594).

This species is well marked by the crowded terminal inflorescence and the white-tomentose reticulate leaves. It is probably related to *H. pectinata* (L.) Poit.

Solanum gonaivense Leonard, sp. nov.

Shrub about 2 meters high; branches slender, terete, grayish, stellate-pubescent; spines in pairs at the base of the leaves and branches, 2 to 5 mm. long, slender, recurved, glabrous; leaves 1 to several on minute axillary branches, rosulate; petioles 0.5 to 1 mm. long; leaf blades oblong or narrowly obovate, 3 to 8 mm. long, 2 to 3 mm. wide, rounded at apex, narrowed or rounded at base, both surfaces stellate-tomentose, entire, the midrib and the 2 or 3 pairs of lateral veins obscure; flowers few, solitary and terminal on the leaf-rosettes; pedicels 1 to 4 mm. long, stellate-tomentose; calyx 3 to 4 mm. long, stellate-tomentose, the lobes 4, linear-oblong, unequal, 3 to 4 mm. long, 1 mm. broad, rounded at apex; corolla white, 8 to 9 mm. long, the tube 1 mm. long, the lobes 4, narrowly lanceolate, blunt at apex, minutely stellate-pubescent without, glabrous within, stamens 4, attached to corolla tube 0.5 mm. above the base, the anthers linear-lanceolate, 6 to 7 mm. long, blunt at apex, subcordate at base, the filaments 0.5 mm. long; style 8 mm. long, glabrous, ovary globose, 0.75 mm. in diameter, glabrous; mature fruit not seen.

Type in the U. S. National Herbarium, no. 1,301,034, collected in an arid thicket on the Ennery Road about 8 miles northeast of Gonaives, Département de l'Artibonite, February 19, 1926, by E. C. Leonard (no. 10,007).

This plant is closely related to *S. microphyllum* (Lam.) Dun. and may be merely a variety or form of that species. It differs chiefly in the much smaller leaves and flowers.

Brunfelsia abbottii Leonard, sp. nov.

Shrub; older stems gray, minutely reticulate, glabrous, papillose, sometimes flaky, the tips pubescent with small curved hairs; petioles about 5 mm. long, glabrous or sparingly pubescent with small curved hairs; leaf blades lance-elliptic, 6 to 10 cm. long, 2 to 3 cm. broad, gradually narrowed to base, acuminate at apex, both surfaces sparingly pubescent, minutely reticulate above, minutely scurfy (?) beneath, the midrib impressed above, prominent beneath; flower terminal; calyx 1 cm. long, glabrous and somewhat scurfy, the lobes oblong, 2.5 mm. long, 2 mm. broad, obtuse or subtruncate, narrowed

slightly at middle; corolla white (?), 8.5 to 9 cm. long, the tube slender, about 7 mm. broad at throat, gradually narrowed to 3 or 4 mm. at base, glabrous without, pubescent within, especially at throat, the limb 3.5 cm. broad, spreading, the lobes rounded; stamens didynamous, the upper pair reaching nearly to the throat, the lower pair about 5 mm. shorter; anthers lunate, about 4 mm. long, the filaments attached at center of concave side; style exceeding the lower pair of stamens; stigma 2.5 mm. broad; ovary 2 mm. long, oval, glabrous.

Type in the U. S. National Herbarium, no. 1,147,362, collected on the upper slopes of Loma Atravezada, base of Punta Cabrón, Samaná Peninsula, Dominican Republic, altitude 300 to 600 meters, December 14, 1923, by W. L. Abbott (no. 2937). Abbott's 280 collected on the summit of Pilón Azúcar near Samaná, altitude 500 meters, December 18, 1920, belongs to this species. This specimen consists of a twig bearing leaves and a single fruit. The leaves are thinner and slightly larger than those of the type. The fruit is almost globular, glabrous, and about 18 mm. in diameter, the pericarp glabrous, shining, and yellow within. The seeds are light brown, 2.5 mm. long, 2 mm. broad, round at both ends, oval in cross-section, with a straight and a curved side, and deeply but minutely reticulate.

This is a very distinct species which bears but little resemblance to any *Brunfelsia* hitherto described from the West Indies.

Calamagrostis leonardi Chase, sp. nov.

Plant perennial; culms 60 to 100 cm. tall, slender, ascending, solitary or few together, compressed, glabrous; nodes dark, glabrous, the lower geniculate; sheaths mostly shorter than the internodes, strongly nerved, the lower minutely retrorsely pubescent, shredded in age, the upper glabrous; ligule hyaline, 3 to 4 mm. long, erose; blades lax, flat, 6 to 20 cm. long, 2 to 5 mm. wide, scabrous, mostly minutely ciliate and in some leaves, sparsely pilose on the upper surface; panicle finally long-exserted, pale, nodding, 12 to 20 cm. long, 2 to 4 cm. wide, loosely flowered, the slender ascending scabrous branches 2 to 5 cm. long, mostly in small fascicles, evenly distributed; spikelets erect on slender scabrous pedicels 2 to 5 mm. long; glumes about 4.5 mm. long, equal or the first very slightly shorter, abruptly acute, scabrous on the back and keel, the margins thin, both commonly purple-tinged toward the apex; floret nearly equaling the glumes, the callus bearing copious white hairs about half as long as the floret; lemma 4 to 4.2 mm. long, scabrous on the back and bearing a slender scabrous awn, flexuous and divergent at maturity, a little above the middle, the margins and apex of the lemma thin; palea about 3.5 mm. long; rachilla joint about ⅓ the length of the floret, or slightly longer, long-pilose with white hairs on the outer side and with a few hairs at the summit.

Fig. 1.—Spikelet of *Calamagrostis leonardi*, × 5 dia.

Type in the U. S. National Herbarium, no 1,076,783, collected on red clay, open mountain top, in the vicinity of Furcy, Haiti, 1300 meters altitude, May 26, 1920, by E. C. Leonard (no. 4325). A second collection was made on Mt. Tranchant, in the vicinity of Furcy, *Leonard* 4370.

This species, the only one known from the West Indies, is most nearly related to the South American *C. beyrichiana* Nees, from which it differs in

the abruptly acute not attenuate glumes scarcely exceeding the sessile floret (in *C. beyrichiana* the floret is raised on a short curved rachilla-joint), in the more divergent, more flexuous awn, and in the more copious hairs on the prolonged rachilla joint.

Leptochloa monticola Chase, sp. nov. Plants perennial in dense tough clumps; culms 90 to 100 cm. tall, erect, rigid, simple, scabrous below the slightly constricted glabrous nodes; leaves firm, the sheaths mostly overlapping, minutely ciliate at the truncate summit, otherwise glabrous, the lower somewhat twisted and shredded in age; ligule very minute, almost obsolete; blades 20 to 30 cm. long, 2 to 6 mm. wide (flattened out) involute, somewhat tortuous and with a very thick midrib, glabrous on the outer surface, scabrous, strongly nerved and obscurely pilose on the inner, pungent-pointed, tapering to a narrow base, the blades bending forward past the culm, bringing the outer surface upward; panicle short-exserted, purplish, about 30 cm. long, and 8 cm. wide, the common axis stiff, ridged and scabrous, the numerous racemes approximate, those of the middle as much as 10 cm. long, the upper and lower shorter, all rather stiffly ascending; spikelets distant about half their own length on the slender scabrous rachis, 8 to 10 mm. long, 6 or 7 flowered, the appressed scabrous pedicels 0.5 to 1.5 mm. long; glumes lanceolate-ovate, acute, bronze-tinged with strong scabrous keels and thin margins, the first 2.5 to 3 mm. the second 3.5 to 4 mm. long; rachilla joints 0.3 to 0.4 mm. long, pilose at the summit; lemmas 4.5 to 5 mm. long, lanceolate-ovate, acuminate, the midnerve slightly exserted from between two minute teeth, densely long-pilose at the base, on the midnerve toward the base, and on the lateral nerves from the base to the middle; palea about 1 mm. shorter than the lemma, concave between the keels, the margins sparsely pilose.

Fig. 2.—Spikelet and floret of *Leptochloa monticola*, × 5 dia.

Type in the U. S. National Herbarium, no. 1,077,272, collected on summit of Pic de Brouet, in the vicinity of Furcy, Haiti, altitude about 1300 meters, June 13, 1920, by E. C. Leonard (no. 4751), "common on the summit."

This robust species is very different from any known species of *Leptochloa* especially in the forwardly bent involute blades, which are found only in species (like *Ammophila breviligulata* Fern.) of windswept areas.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY

945TH MEETING

The 945th meeting was held in the auditorium of the Cosmos Club on November 13, 1926. The meeting was called to order by President BOWIE at 8:21 with 43 persons in attendance.

The program for the evening consisted of two papers, followed by motion

pictures of the total solar eclipse of 1926. The first, by W. P. WHITE was on *A new method of avoiding trouble from lag in mercury contact thermostats.*

The paper deals with a form of the familiar mercury-contact type of thermostat or temperature-controller. In that type the "bulb," which is really a gigantic thermometer, contains a mercury contact which turns a heater off or on, so as always to bring the temperature to the fixed value for which the regulator is set. In all such regulators there is a delay, or lag, in getting the heat from the heater to the bulb, so that the heat is always turned on, or off, a little too late. The temperature thus keeps running by the true value, oscillating around that. The resulting temperature variations can be minimized by making the oscillations quicker, which makes them also smaller.

In this form of regulator a very fine heater, inclosed within the bulb, provides for very quick oscillations. This heater is connected with the regular bath heater. Whenever heat is turned on it *instantly* raises the temperature of the bulb, which at once shuts the heat off, only to be turned on again as quickly. Exceedingly rapid oscillations are possible, though a period of a few seconds is preferred. This device is generally more convenient in operation than one where the oscillations are produced by mechanical means, since it adds no moving parts. It applies the minimum of heat to a very small part of the bulb; hence it avoids most of the temperature uncertainty which results when the oscillations are quickened by causing the main heater to heat the bulb from the outside. (*Author's abstract.*)

The paper was discussed by Mr. STIMSON.

The second paper by Mr. G. F. TAYLOR, was entitled *Description of a new type of thermostat.* (Illustrated with lantern slides.) A new type of thermostat is described in which a spherical piston completely submerged in mercury takes the place of a bare mercury to metal contact. The piston is made of one or more small spheres. Each of the spheres is surrounded by a small air space. The surface tension of the mercury as it is forced into the air space exerts a pressure on the piston causing its motion. The piston raises or lowers a magnetized steel weight which makes and breaks electrical contact. The bulb of the thermostat is made of a spiral coil of thin-walled copper tube $\frac{5}{16}$ inch in diameter supported on a frame made of four strips of brass. The piston and contacts are supported in the center of the coil. The bulb is filled with torulene and the piston with mercury. A special valve is provided to keep the mercury and the torulene separate. The torulene will pass freely in either direction through the valve but the mercury will not pass. The instrument may, therefore, be turned in any position without mixing the liquids. An overflow cup at the top of the piston which furnishes mercury and keeps the piston submerged is made in a cellular or honeycomb form so that the mercury will not escape even if the cup is inverted. The instrument has heavy contacts and may be used without a relay to break a current of about four ampheres.

Experiments were described in which a large number of metals and alloys were tried in order to find one which would carry the greatest current with a minimum of deterioration. Pure radium showed the least deterioration, but electrical contact sometimes failed to accompany mechanical contact. An alloy of 80% radium and 20% platinum was found most satisfactory. A method was described for making disc contacts of this non-malleable material. The contacts, which are held tightly together by magnetic attraction, are separated by a spring which causes a sudden and decided break, this, however, at the expense of sensitivity. When very close control is desired, the spring and magnet are not used. In this case the interval between make

and break was between 20 and 40 microns for the thermostat tested. The thermostat is set to any desired temperature by raising or lowering the pin with its attached piston, using sufficient pressure to force the mercury past the piston. A spherical piston, three millimeters in diameter, and about .001 cm. smaller than the tube in which it fits, will support a pressure of 50 grams and the weight supported appears to be proportional to the number of spheres used. A piston of ten spheres should support 1.5 kg. If more than one sphere is used in making the piston, they are strung on a catgut cord. A somewhat larger piston made of a larger number of spheres would do work sufficient to operate mechanical devices such as steam valves or even doors. A thermo-regulator made on this plan has given very satisfactory service for three years in a cold storage plant. The regulator controls the temperature of the brine tank by starting and stopping the compressers. It is also proposed to operate the pen of a thermograph by using a piston to operate the tracing pen instead of a bimetal of Bordon type. The piston being more sturdy would be less susceptible to vibration and would carry the pen along a straight line instead of a curved line. These instruments are covered by U. S. Public Service Patent No. 1484802, reissue No. 15890. (*Author's abstract.*)

The paper was discussed by Messrs. WHITE and ADAMS.

Following the presentation of the papers, motion pictures of the total solar eclipse of 1926 were shown. This was made possible through the courtesy of Mr. JAMES STOKLEY of Science Service.

946TH MEETING

The 946th meeting was held at the Cosmos Club on Saturday evening, November 27, 1926. The meeting was called to order by President BOWIE at 8:17 with 33 persons in attendance.

The program for the evening consisted of two papers. The first by F. L. MOHLER was on *Spectra excited by atomic hydrogen.* (Illustrated with lantern slides.) Hydrogen from a Wood discharge tube flowed into a tube containing metal vapor and the spectrum emitted by the mixture was photographed. Observations of Bonhoeffer (Zeitschr. f. Phys. chem. **116**: 391, 1925) with sodium and mercury are confirmed. Sodium and cadmium gave strong emission of their first resonance lines and no other lines or bands. Potassium showed the first resonance line faintly. Mercury gave the complete hydride band spectrum and also faint emission of the resonance line at 2537 A. caesium, magnesium thallium and zinc gave no line or band spectra. The excitation energies of the observed lines and bands are, except for 2537 of mercury, less than 3.8 volts, though many lines of lower energy did not appear. There are two possible explanations of the radiation. The metal atom may be excited in a three body collision with two hydrogen atoms. In this case the entire energy of recombination of hydrogen, 4.38 volts, should be available for excitation. The second possibility is that first a hydride is formed and that this reacts with H to form H_2 and an excited metal atom. The available energy of excitation is the energy of recombination of H minus the energy of formation of the hydride. The second theory seems to offer the best explanation of the observations. (*Author's abstract.*)

The subject was discussed by Messrs. BREIT, CURTIS and HAWKESWORTH.

The second paper, by W. G. BROMBACHER was entitled *Discussion of a barometric method of measuring aircraft altitudes.* (Illustrated with lantern slides.) The altitude of aircraft is indicated to the pilot by an aneroid ba-

rometer calibrated in altitude according to an altitude-pressure-temperature relation. This is, for the United States, up to 35,332 feet,

$$Z = 63691.8\ T_m \log \frac{(760)}{P}$$

$$T = 288 - 0.001982\ Z$$

$$T_m = \frac{0.001982\ Z}{\log_e \left(\frac{288}{288 - 0.001982\ Z}\right)}$$

in which Z is the standard altitude in feet; P, the pressure in millimeters of mercury; T and T_m the absolute temperature and absolute mean temperature respectively in degrees Centigrade. The variation in the indication from the altitude due to seasonal changes in air temperature amounts roughly to 5 per cent.

The principal objection to this method of determining altitude lies in the fact that pressure levels are indicated, not the elevation above the surface of the earth. Knowledge of the elevation is important for many purposes, especially for landing when the visibility is poor. The indication at the ground level usually varies with time due to both the variation in the barometric pressure and the changing elevation of the ground underneath the aircraft. The barometric pressure at the ground has a variation roughly equivalent to 25 feet per hour change in altitude during the passage of a well defined cyclone. If a landing is to be made in such circumstances and if the position of the pointer at 760 millimeters is suitably marked, the following procedure is suggested for obtaining the elevation. The landing field personnel, at request, reads the barometer and radios the negative of the corresponding standard altitude to the aircraft. The pilot adjusts the altimeter dial so that the 760 millimeter mark and the altitude received by ratio correspond. The elevation of the landing field is now indicated by the altimeter.

The performance of altimeters has been greatly improved since 1918, especially the elastic properties. The maximum hysteresis (the maximum difference in reading) of good instruments at a given altitude, for decreasing and increasing pressures, has been reduced to one-half. This difference at the ground level, known as the after-effect, has been reduced from approximately 200 feet to 50 feet or less.

An improvement now in progress is that of compensation for the effect of the seasonal variation in air temperature. This compensation may be achieved either automatically or through manual control. The mechanism of an instrument of the automatic type now under construction was shown in order to illustrate the method. Essentially, the mechanism is adjusted by a bimetallic strip or manually so that the multiplication is modified as required by the particular air temperature existing at the time. (*Author's abstract.*)

The paper was discussed by Messrs. JUDSON, BOWIE, TUCKERMAN and HUMPHREYS.

President BOWIE then called upon Dr. TUCKERMAN who spoke informally on the arrangements for the 25th anniversary of the Bureau of Standards, to take place on Dec. 4th. Following this, President BOWIE spoke briefly on the accuracy now attainable in geodetic work.

H. A. MARMER, *Recording Secretary.*